Available online at www.sciencedirect.com
SCIENCE DIRECT
Physica B 359–361 (2005) 47–49
PHYSICA B
www.elsevier.com/locate/physb

Spin dynamics in $YbRh_2Si_2$ probed by ESR

G.I. Mironov[a], V.A. Ivanshin[b,*]

[a]*Mari State Pedagogical Institute, 424002 Yoshkar-Ola, Russian Federation*
[b]*MRS Laboratory, Faculty of Physics, Kazan State University, Kremlevskaya str. 18, 420008 Kazan, Russian Federation*

Abstract

Recent electron spin resonance (ESR) experiments in the heavy-fermion metal $YbRh_2Si_2$ are discussed. A new approach is proposed for explanation of the first observation of ESR of a Kondo ion in a dense Kondo lattice system. Exchange interactions between the subsystems of the localized Yb^{3+} magnetic moments and itinerant electrons have been analyzed under conditions of their collective motion. Expressions for the effective ESR linewidth and g-factor with regard to the electron bottleneck and Kondo effect are obtained. The theoretical fits explain the experimental ESR data quite well.

PACS: 71.27.+a; 75.20.Hr; 76.30.−v

Keywords: Heavy-fermion metal; Electron spin resonance; Electron bottleneck

A simple single-ion Kondo scenario (see, for e.g. Ref. [1]) fails to join the magnetic and transport properties of the dense heavy-fermion (HF) metal $YbRh_2Si_2$ and to explain the recent observation of electron spin resonance (ESR) [2,3] in this compound exhibiting the properties of a so-called non-Fermi liquid behavior [4]. As a rule, the observation of ESR in concentrated HF compounds is hampered because of a strong ESR line broadening [5]. However, the strongly anisotropic ESR spectrum (ESR linewidth $\Delta H \sim 200\,$G at 4.2 K) ascribed to the Yb^{3+}-ions ($4f^{13}$, $J = \frac{7}{2}$ has been detected in $YbRh_2Si_2$ single crystals below 25 K. The detailed analysis of the experimental data for the temperature dependence of the effective g-factor and ESR linewidth [2,6] leads to a conclusion that the anomalous reduction of the relaxation rate of the ytterbium spins in $YbRh_2Si_2$ can be understood in terms of the exchange interactions between the subsystems of the localized Yb magnetic moments and conduction electrons under conditions of their collective motion. For a subsystem of the conduction electrons in an external magnetic field, the s–d(f)

*Corresponding author. Tel.: +7 8432 315 306; fax: +7 8432 387 201.
E-mail address: vladimir.ivanshin@ksu.ru (V.A. Ivanshin).

0921-4526/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.physb.2004.12.052